

THE PREVALENCE AND CHARACTER OF TUBERCULOSIS IN HONGKONG

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I. GENERAL CONSIDERATIONS

The statement has been made that not only is tuberculosis a common disease in the tropics, but that it appears to be increasing in its ravages in the East. Seeing that the treatment of tuberculosis, both prophylactic and curative, consists largely in fresh air and sunshine, it seems strange that this disease should be rife in tropical countries where sunshine is so prevalent and living in the open air is the rule.

A very brief experience as medical officer in charge of the mortuary sufficed to show that tuberculosis was a frequent cause of death in Hongkong, and I deemed it an investigation well worth undertaking to determine the varieties of the disease as met with here, the portals of entry, the mode of spread, and, if possible, to determine the primal cause or causes responsible for the condition and those aiding its dissemination, with a view to elucidating measures for its prevention.

I have excluded those cases which showed merely signs of old-standing tuberculosis, for previous investigations have proved that after middle life nearly all bodies yield evidence of some healed focus of the disease. A particularly noticeable feature in my series is the large percentage of children of tender age who die from tuberculosis. Another point worthy of note is the fact that whereas at home intestinal tuberculosis as a primary condition is fairly common in children and is ascribed to the drinking of infected milk, in tropical countries primary intestinal tuberculosis is met with although milk

is not taken as a regular food; this holds good here also, though it is only right to add that primary intestinal infection appears to be comparatively rare in Hongkong.

Before proceeding to speak in detail of the cases dealt with in this investigation, it will not be out of place to make a few general remarks on the disease. As is well known, the bacillus may persist for a long time in dust, in dried sputum, in urine, and so forth. When one sees how large a number of patients exhibit signs of tuberculosis after death, several of whom showed no marked signs during life, and when, as we know, the bacilli are shed broadcast not only in the sputum but in the fine spray of coughing and sneezing consumptives, the opportunities for the organism to gain entrance and to propagate are many. Thus, the bacillus has been found in the sweepings of rooms (Manfredi at Naples, Marpmann at Leipzig), on fruit exposed for sale (Schnirer), in the wards of hospitals (Strauss, Le Noir), in books, in the bodies of flies (Nuttall, André), on clothes (Josephson, Nötel, Chaussé), as quoted by Etienne Burnet: 'Ou trouve comme une quintessence des poussières atmosphériques dans ces poussières fines que l'on pompe par le vide (vacuum cleaner); avec elles s'est déposé ce qu'il y a de plus léger dans ce que soulèvent nos semelles et l'intense circulation de nos rues, et ce que crache une population malheureusement trop insouciante.'

As stated by Delépine, the difficulties of elucidating the causes of an infectious disease depend on the fact that we must take account of the various ways in which the predisposing and determining factors have combined in their action, and the difficulties are increased when we attempt to assign to each its appropriate share. He groups these factors under the following heads: (1) Distribution and habits of the pathogenic organism. (2) Conditions influencing its number. (3) The pathogenicity and toxicity of it, or, in other words, the conditions influencing its virulence. (4) The opportunities which the organism may have of gaining access to one or more channels of infection. (5) The conditions influencing the resistance which any possible host may be capable of opposing to the attacks of the organism. (6) The frequency and degree of completeness of recovery from occult or manifest infection. This comes into play more with regard to the question of adult tuber-

culosis, whereas the present investigation is concerned with the disease as found in children.

Of these factors those of special importance are the number and virulence of the organism on the one side and the degree of resistance which the subject attacked may be able to oppose on the other.

There appears to be no doubt that the resistance set up, if not adequate for the destruction of the organism, even contributes indirectly to an increase in the virulence of the latter. Thus, an organism, *e.g.*, the *Bacillus tuberculosis* of reduced virulence in milk, after inoculation was found to gain in virulence according as the distance from the site of inoculation increased. The resistance offered to the invading organism being insufficient to destroy it, trained it, as it were, to develop more inimical powers of attack, so that, as the bacilli overcame successively the barriers placed in their path, they increased not only in virulence but in number also, just as the *Virus fixe* of rabies was obtained by Pasteur by means of passage of the street virus through a series of animals. This process has been designated a 'reinforcement by relays.' The overcoming of this resistance by an organism of feeble aggressive powers of course takes time whether the delay is caused by the small number of organisms, or by their being of reduced virulence, or by the greater degree of resistance set up leading to a 'relatively reduced virulence.' One or other of these, acting singly or in combination, may be adduced to account for latency.

Where cases are met with in which death occurs at such a tender age as 22 days (No. 128),* 24 days (No. 214), 29 days (No. 180), and 7 weeks (Nos. 63 and 114), one is naturally led to enquire into the question of congenital and hereditary tuberculosis.

The possible modes of congenital infection are, of course, either by the ovum or spermatozoon, or via the placenta from a tuberculous mother. As regards the first of these, as Adami states, 'the microbe of an infectious disease cannot be a constituent of the biophore. At most it can be an accidental inclusion in the surrounding non-heritable matter of the cell.' The human ovum, being practically

* The serial numbers refer to those contained in a table showing the post-mortem findings of the 300 cases of tuberculosis under consideration. The Editors regret that it is not possible to reproduce this table.

free from yolk and not being phagocytic, cannot take up the bacilli, while it is still more improbable that the minute spermatozoon could carry them. Repeated observations go to show that the semen of a phthisical patient (Rohlf, Gaertner) does not contain as many as ten bacilli, and as the average human seminal ejaculation is said to contain over 200 million spermatozoa, the chances that a single spermatozoon which fertilises the ovum should carry a bacillus are about one to twenty million. For practical purposes this mode of infection may be regarded as impossible. The second method, via the placenta of a tuberculous mother (or perhaps through the walls of the foetal sac, or passing to the foetus before the sac forms), has been shown to be possible; in fact, intra-uterine acquirement of disease as distinct from inherited disease is proved. Such transmission of the tubercle bacillus from parent to child *in utero*, is however, undoubtedly very rare. Thus Schluster, who examined into the records of the reported cases, as mentioned by Latham, was able to collect only twelve showing clinical evidence of tuberculosis at birth. Furthermore, in the majority of instances, the organs of foetuses born of tuberculous mothers yield only negative results when inoculated into guinea-pigs.

The theory of diathesis—the question as to whether the children of tuberculous parents suffer from a greater liability to tuberculosis from enhanced susceptibility resulting from ‘paratuberculous lesions’ due to toxic action on the germ cells—the hereditary transmission of constitutional predisposition to tuberculosis, is being relegated more and more to the realms of improbability as modern knowledge, with its insistence on accuracy of detail, demands facts and proofs in place of nebulous hypotheses.

The dominating factor in the incidence of tuberculosis is the opportunity for infection; in other words, the greater the opportunity for infection the greater is the incidence and the mortality from this disease. Can we argue that the reverse of this also holds good, namely, that a high incidence and mortality mean greater opportunities for infection? Probably we can, as will be shown later when the local conditions are mentioned.

It would appear to be established that under certain circumstances, no matter what the ‘diathesis’ may be, infection can always be effective. To prove that some children inherit a predisposition

to tuberculosis, the incidence of the disease amongst the offspring of tuberculous parents and amongst equal numbers of non-tuberculous parents would have to be compared, and, furthermore, it would be essential that both should be subjected to the same environment from birth, as McFadyean has pointed out. Even then we must bear in mind the fact that the former will have been exposed to infection during the intra-uterine period, so that the conditions for comparison will not be strictly impartial. To compare, as has been done, the death-rate from tuberculosis amongst members of the two categories—the children of healthy parents on the one hand and those of tuberculous parents on the other—is fraught with fallacy, as the after conditions are so diverse. To make them more equable it would be necessary for the children of healthy parents to be born in infected houses or be placed there at birth, clearly an impossible condition except by mere accident.

The children of tuberculous parents are thus handicapped in several ways, each of which plays a part in rendering fallacious the comparison of their death-rate with that among children of healthy parents. The chief of these disturbing factors would be: (1) Intra-uterine exposure. (2) Birth in infected surroundings, and, therefore, greater liability to infection while young. (3) The dose of infecting material is likely to be large. (4) This dose is probably frequently repeated.

That the intra-uterine period may be dangerous to the child from the point of view of tuberculosis has been definitely proved, though the cases on record are very exceptional. Thus Schmorr and Birch-Hirschfeld, and Schmorr and Kockel, have described cases in which the bacilli were found in the placentae and the foetuses of tuberculous mothers. More recently Friedmann reported the finding of two cases of tuberculous infection by the placental route.

So much for the question of hereditary transmission of the *Bacillus tuberculosis*. As regards environment no one now disputes the importance of this factor in producing the disease, but though comparison is difficult in human beings owing to the variety of disturbing factors, as has already been stated, in animals we can better arrange conditions to suit our purpose. The experiments of Trudeau may be referred to in this connection. He inoculated

rabbits with tuberculosis and allowed some to run wild, whereas others were kept in a damp, dark place. Most of the former recovered, while the latter rapidly succumbed.

In cattle an analogous condition is found. As McFadyean states: 'All breeds and strains of cattle are susceptible to tuberculosis, and when the environment is the same the incidence of the disease is the same in all breeds and strains.' He found that the conditions under which the cattle are bred and reared constituted the most important contributory factor according to the opportunity supplied by the environment for the transmission of the bacilli. Regardless of breed as a separate factor, the proportion of cases of tuberculosis furnished by any breed is high or low according as the cattle are or are not in close association with other diseased animals. Calmette's experiments lend additional support to the same fact. He found that cattle which had been once infected nearly always recovered if they were carefully isolated, but if kept in prolonged contact with tuberculous animals they themselves became actively tuberculous.

So in man no race is exempt; in other words, there is a racial susceptibility to tuberculous infection, but there is not sufficient evidence at present to enable one to say that any *special* predisposition is handed on by tuberculous parents to their offspring.

We may summarise the matter by saying, firstly, that hereditary transmission of the bacillus is so rare that for practical purposes it may be declared negligible; secondly, that the incidence of tuberculosis depends on two main factors, namely, the dose received and the virulence of the strain inoculated; in other words, the degree of exposure to infection and the resistance which the inoculated subject is able to put forward, this, in turn, being dependent largely on his environment; thirdly, that there is not sufficient evidence, at present at all events, to afford support to the theory that there is such a thing as inherited predisposition to tuberculosis.

Before passing on to a more detailed description of some of the 300 cases of death from tuberculosis, the morbid anatomy of which forms the basis of these studies, it will be advantageous to say a few words on the extent to which the foregoing points are exemplified in the conditions prevailing in Hongkong.

Generally speaking, the prevalence of the disease is closely connected with social and economic conditions—overcrowding and slums, poverty, insanitation, and squalor. The ingestion of tuberculous milk, which is supposed to play a large part in the production of tuberculosis, especially intestinal tuberculosis, in children in England, has no influence here, for the Chinese children do not drink milk, nor does it arise here from the use of tuberculous meat.

The problems of tuberculosis in Hongkong are really social problems, and are, therefore, intimately connected with those of public health. The main causes of the prevalence of the scourge are the predisposing ones of overcrowding of the poor and the fact that the rooms inhabited by them are dark and the sunlight rarely enters them. They are still further darkened by gratings and shutters.

With the first of these there is little if anything to be done; the population is great and the space for their accommodation relatively small; not only is floor space inadequate, but window space is less than it should be, and the windows are often closed and made of opaque or coloured glass, so that the penetration of light is reduced to a minimum. This latter question of the darkening of the rooms can only be improved by education.

In an interesting paper on "Sanitary Progress in Hongkong," Dr. W. W. Pearse, the Medical Officer of Health, states with reference to the housing of the poorer Chinese that, the area being limited and the Chinese population large and constantly increasing, building sites have become very expensive so that the streets inhabited by this class of person are narrow, and the houses fronting on them high; in some cases the height is five times the width of the street.

'It is usual,' writes Dr. Pearse, 'to speak of the Chinese houses as being of one or more storeys, but as each storey was generally let separately, and as the occupiers of each storey used it as they would have used their single storey house in their native village in China, in effect these Chinese houses in Victoria were piled one on another, three, four and five high!

'Another factor has contributed curiously to produce the ill-designed Chinese house of Hongkong. The floors of these houses are supported by China fir poles. A pole of more than fifteen feet

long of sufficient strength for a floor joist is not readily procurable. This has limited the width of storeys to fifteen feet.

'In order to provide as much accommodation per floor as possible, *i.e.*, to make building pay, the area of a floor has been obtained by increasing its depth out of all proportion to its width.

'Hence a Chinese house in Hongkong has been a veritable tunnel fifteen feet wide and forty, fifty and even sixty feet deep.

'Excepting corner houses only, windows to light and ventilate these tunnels were possible only at the front and in front of these were verandahs.

'Windows at the rear of houses were not at first considered necessary, and many houses were built back to back, with no yard or ventilating shaft between them. On each floor the rear portion was cut off by a partition wall to form a kitchen. Such kitchens were small, generally under 150 square feet in area, very dark, and often with no means of ventilation other than the door communicating with the main portion of the floor. These kitchens were drained by vertical earthenware waste pipes which, in the case of back to back houses, were carried down through the building to discharge over a gully trap in the kitchen on the ground floor.'

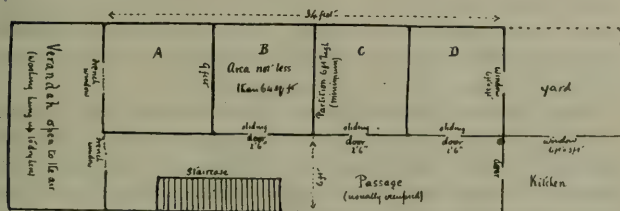
From time to time laws have been passed to improve the housing conditions by providing open spaces of a defined minimum area at the rear for ventilation. Later, all new houses were required to have larger back yards, and also scavenging lanes. Further, regular systematic cleansing of the Chinese houses was instituted (in 1903) and certain repairs effected. These measures were really directed towards the eradication or limitation of plague, and were aimed at affording protection from infestation with rats.

The method of cleansing the houses is carried out in the following manner four times a year: the furniture is turned out, the bed-boards and such like are dipped in 1 per cent. kerosene in water, in order to get rid of vermin; the floors also are sprayed with the same liquid. All rubbish and dirt generally are removed, and an inspector makes a careful examination to see if any floors need repair, if any gratings are missing, and so on.

The accompanying diagram, kindly drawn for me by Dr. W. J. Woodman, late Acting Medical Officer of Health for Hongkong, and now M.O.H., Kewleen, shows the arrangement and mode of

occupation of a typical 'floor' of a modern Chinese house in these districts.

The foregoing constitute the main predisposing causes, but the direct cause of the prevalence of tuberculosis in Hongkong is, *facile princeps*, the expectoration habit. Nearly all writers on tuberculosis in the tropics note this peculiar trait. In the houses of the poor a person will expectorate anywhere on the floor, or, if he is ill in bed, on the bed clothes. Owing to the unavoidable overcrowding in the poorer districts the children play about on the floor, putting everything into their mouths, breathing a vitiated



atmosphere and one often tubercle-laden. These are the reasons for the extensive prevalence of tuberculosis among the native population here and for the relatively high proportion of cases met with among children. A subsidiary but analogous cause is that manner of feeding their infants which many mothers, themselves tuberculous in some instances at least, indulge in, of first chewing the food and then placing it in the mouths of their babies.

Further, experiment has shown that there is considerable danger of transmission of tubercle bacilli from one person to another by means of eating utensils, if these are uncleaned. In China the eating together is common, the using of the same general dish, the insertion of individual chopsticks into the food supplied for the meal, the transference of food with the chopsticks of one person to the mouth or dish of another—all these afford a ready means of conveyance of the organism, but readily preventable when it once comes to be recognised.

These, however, are not so important as the one first named—the

expectoration habit—for intestinal tuberculosis, as shown in this series, is not the common mode of infection of children out here.

Dr. Chaussé compared the infection arising from dried sputum and that from droplets of sputum and saliva directly inhaled, and laid stress on the fact that it is exceptional for those living with tuberculous subjects to receive directly the cough of the latter, and the droplets are very soon diluted with a large quantity of air, and thus danger is lessened. Further, these droplets dry very quickly and their virulence is probably much diminished in ten days. Deposition occurs in a few hours at most, and, owing to the deposition and the drying, the droplets become reduced to the condition of infective dust. 'Les gouttelettes bacillaires elles-même, comme facteurs de contagion de la phthisie jouent la plus grande partie de leur rôle après leur dépôt et sous la forme de poussières sèches, de nouveau mobilisées dans l'atmosphère.'

When no precautions are taken, and this is the rule, the clothes, bedding, etc., are soiled by the virus in large quantity. Then the making up of the bed, brushing of clothes, sweeping the floor, distribute the organisms so that healthy contacts become exposed to infection every day and all day long, for this dust may remain suspended for several hours. Moreover, currents of air, movements on the part of the patients, continually put the dust in motion.

Then, when the colder months come on the Chinese take out their old clothing which has been stored away in some cupboard or dark corner and wear that over their other garments. When the house cleansing takes place these clothes are not disinfected, so that they are nearly, if not quite, as infectious as when they were laid aside at the termination of the previous cold weather.

Nuttall has estimated that a patient with open tuberculosis may expectorate four thousand million bacilli daily. In a dark, shut-in room the chances of infection for a child brought in contact with such a case are enormous. During the crawling age these chances are still greater. It will be seen on perusal of the age table appended that of the two hundred and twenty-five cases under ten years of age, one hundred and sixty-three, or 72·8 per cent., were three years old or less, and one hundred and eighty-five, or 82·2 per cent., under four years. Further, Dieudonné of Warzburg (1903) has proved that the nasal secretion and dirt on the hands of children

during the crawling age, say nine months to three and a half years, in a very large proportion showed the presence of tubercle bacilli. The opportunities for the repeated infection of a child of the crawling age in contact with a person suffering from open tuberculosis, or even living in a room previously occupied by such a person, are enormous. The danger of infection from tuberculous members of a family is not, according to the weight of evidence now available, due to the mere 'tendency to infection,' or even to the increased probability of infection *per se*, but is to be ascribed to the probable large size and frequency of the infecting doses. It has been shown experimentally that small repeated infections may be protective, but large ones overwhelm. Thus is explained the apparent antagonism of Calmette's and of Bryant's experiments. The former have already been mentioned with reference to single or repeated infection of cattle, either directly or by keeping them in contact with tuberculous animals. Bryant, after injecting guinea-pigs with a small number (eight) of bacilli daily for a time and then every three days for a period of four months, found lesions indicative of great resistance.

The conditions in Hongkong, as has been pointed out, are analogous to the experiments of Calmette. It is needless to labour this point further, but in conclusion mention may be made of Theobald Smith's statement in the *Journal of the American Medical Association*: 'The resistance of the tuberculous animal to superinfection is readily broken down by slightly increased dosage, and is successful only when very minute doses come into play.'

As already mentioned, the prevalence of tuberculosis is closely connected with social and economic conditions—overcrowding and slums, poverty, insanitation and squalor. With regard to overcrowding, little, if anything, can be done; the space available is limited, and the population is relatively large and is increasing. The question reduces itself, for practical purposes, to the finding of a remedy for the spitting habit in the first place. The use of food utensils, bowls, chopsticks, etc., in common probably plays a very subordinate part, as has been stated above. To exact, or rather to inflict fines for spitting in public would be useless for several reasons: firstly, the offenders cannot afford to pay fines; secondly, the native police are every bit as bad offenders in this respect as the rest; thirdly, I am convinced that it is the expectoration on the floors of the rooms in which the people live that is the chief source of the bacilli,

so that, even if expectorating in public out of doors were stopped—‘a consummation devoutly to be wished’ on other accounts than the risk of disseminating tubercle bacilli—there would be no deterrent to a man exercising the privilege in his own rooms, unless his wife objected, and this she would not do seeing that she also freely avails herself of a like privilege. We are, therefore, reduced to the slower but more certain method—Education, and the question naturally follows: How and by whom? European doctors would be of little, if any, use directly. They do not come into contact with the poor to any extent, and they would not be listened to even if they could succeed in making themselves understood. The Chinese doctors would have a better chance, and, therefore, much may be hoped from the locally qualified practitioner who comes more into contact with the people, both at the hospital during his years of training and also after he graduates and goes into practice.

Better still would it be to attempt to instruct the people in their houses, and this, I venture to suggest, could be accomplished in the following way:—The Y.M.C.A. and the Y.W.C.A., to which many of the better educated classes belong, have courses of lectures from time to time on various subjects. Like all the laity they are interested in medical questions, and there is no reason why popular (or, to use Huxley’s preferable term, people’s) lectures and demonstrations should not be given at these institutions, and such lectures on medical subjects never fail to draw. This would form a nucleus, and from among the members, the women more than the men, some would certainly be found to spread the glad tidings of the gospel of health, at first in their own homes among their servants, and later tactfully to promulgate the doctrines they had been taught. After a time a regular system of district visitors (in the medical sense) might be inaugurated; these would not only instruct the mothers in child welfare and the dangers of feeding their children in the way indicated earlier, but would instil into the adults, and, through them, the growing children health principles generally. The teachers of the Chinese attending British schools might also with advantage incorporate elementary hygienic principles as object lessons for their pupils. Then the question of the establishment of a tuberculosis dispensary would come up for consideration. The Chinese are very fond of their children, and the appalling mortality from tuberculosis must be ascribed to ignorance and not to perversity.

TABLE I.
Showing distribution of the 300 cases according to age and sex.

	Sex	6 months or under	1-1½ years	2-3 years	3-4 years	4-5 years	5-10 years	Total up to 10 years	10-15 years	15-20 years	Total 10-20 years	20-30 years	30-40 years	40-50 years	50-60 years	Over 60 years	Total over 20 years
First hundred ...	M.	...	7	7	2	2	7	30	4	...	4	2	1	8	1	2	14
	F.	7	6	4	5	2	4	46	1	...	1	3	1	...	...	1	5
Second hundred ...	M.	3	5	5	6	1	3	32	...	...	...	6	3	8	3	...	20
	F.	3	4	8	2	2	8	41	2	1	3	1	1	1	1	...	4
Third hundred ...	M.	7	8	5	4	2	2	37	...	1	1	3	5	3	3	3	17
	F.	5	7	5	3	2	5	39	...	1	1	2	2	1	...	...	5
Whole three hundred ...	M.	10	17	17	12	5	12	99	4	1	5	11	9	19	7	5	51
	F.	15	29	17	10	6	17	126	3	2	5	6	4	2	1	1	14
Total, both sexes		25	46	34	22	11	29	225	7	3	10	17	13	21	8	6	65

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